put together. The robustness was assessed by applying Hounsfield unit (HU) perturbations of 3.5% and isocenter shifts of 5mm. Single beam optimisation (SBO) using a horizontal beam line was used when possible. PTV constraints were D2% < 107%, D98% > 90% and V95% > 95% (ICRU). Limits to organs-at-risk (OAR) were the dose-surface area for the skin A60Gy (RBE) < 20cm2 [2], maximum dose to the bones DRBE, 2% < 60 Gy (RBE), maximum dose to the nerves and vessels DRBE, 2% < 70 Gy (RBE).

[1] Haas et al 2012 IJROBP 84: 572-580
[2] Sugahara et al 2012 RadiotherOncol 105: 226-231

Results: Patients with field lengths < 18cm (PTV volumes: 164-659 cm3) could be treated with SBO using 2 horizontal beams and table rotation. In the nominal plan, PTVV95% ranged from 96.3-98.9%. SkinA60Gy (RBE) was 10±7.5cm2. Treatment plans were robust against HU perturbations and 5mm shifts in sup-inf and right-left direction with V95 never dropping below 93%. D2% and D98% of the PTV and OAR doses never exceeded the limits. Shifts of 5mm in ant-post direction caused severe underdosage in the PTV down to V95% of 68%. Robust optimisation in ant-post direction could increase these values up to 91%.
For larger PTVs (420 cm3-2240cm3) field lengths ranged from 25-34 cm. The length of the field overlapping region essentially influenced the robustness of the treatment plans. Isocenter shifts of 5mm to each other or apart resulted in a PTVD2% change of 7% for an overlap >6cm increasing up to 15% for ≤ 6cm (Figure 1).

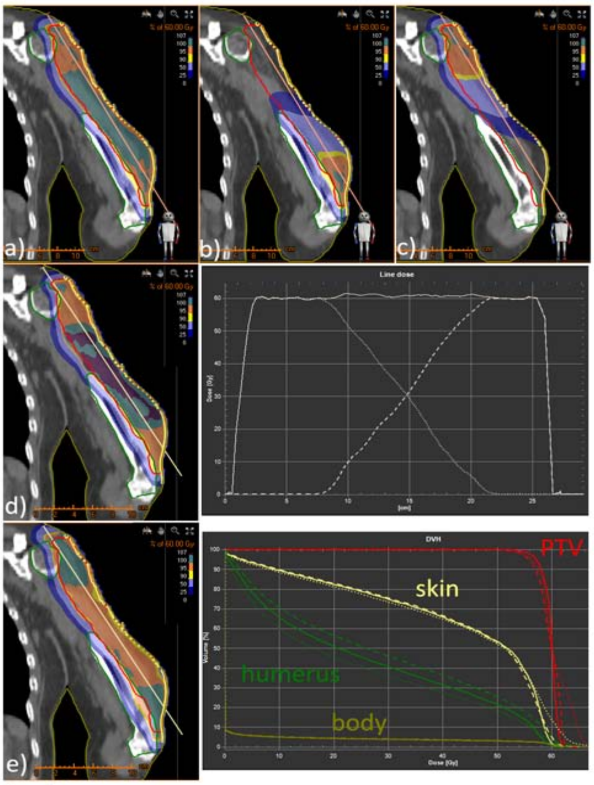

Figure 1
a) nominal plan with one matching boarder of a representative patient with a field overlap > 6cm with the respective line doses ; b) caudal field; c) cranial field
d) + e) isocenters of the two matching fields shifted by 1 cm to each other and apart with the corresponding DVH curves (solid: nominal plan; dotted: isocenters shifted to each other; dashed: isocenters shifted apart)

Conclusion: Robust treatment plans could be achieved for ESTS patients employing a horizontal beam line only. Before clinical implementation, dosimetric monitoring of skin doses should be performed to verify the calculated values. If field matching is needed a maximal overlap of the matching fields should be guaranteed to avoid hot or cold spots in the overlapping area.

EP-1635

Volumetric modulated arc therapy optimization including dynamic collimator rotation

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Purpose or Objective: During the last couple of years, volumetric modulated arc therapy (VMAT) is a treatment modality of increasing interest in radiation oncology. Thereby VMAT utilizes dynamic gantry rotation, dynamic MLC and varying dose rate. However, in addition the collimator angle could be changed dynamically, thus, increasing the degrees of freedom for the optimization, which might lead to improved dose distributions. This work investigates the feasibility of VMAT optimization including a dynamic collimator rotation.

Material and Methods: In this work a 20 x 20 x 20 cm^3 homogeneous water phantom with a cigar shaped target volume and a close-by spherical shaped critical structure was used. By means of the Eclipse Research Scripting a predefined collimator rotation was included to a partial arc in a not yet optimized treatment plan. For this purpose a different collimator angle was assigned for each dicom control point. Thereby the collimator rotation takes into account the physical limitations for the dose delivery. This treatment plan was then imported into the treatment planning system Eclipse using the Eclipse Research Scripting interface. Then the VMAT optimization was performed applying the PRO3 optimization algorithm in a research version of Eclipse. For the dose calculation of the optimized treatment plan the Swiss Monte Carlo Plan (SMCP) was used [1]. Similarly, a dose distribution was determined using a static collimator angle as typically applied in conventional VMAT applications. The resulting DVHs for the target and the critical structure were compared for the treatment plans.

Results: The optimization of a VMAT treatment plan with a dynamically rotating collimator was successfully performed. The comparison of the DVHs for the target volume showed a slight improvement of the coverage as well as the dose homogeneity for the treatment plan using dynamic collimator rotation compared to the plan applying a fixed collimator angle. Additionally, the dose to the critical structure could be reduced when using the dynamic collimator rotation instead of a fixed collimator angle.

Conclusion: The usage of a dynamic collimator rotation for VMAT is feasible and has the potential to improve the dose distribution for the target while reducing the dose to critical structures. This work was supported by Varian Medical Systems.

References:

[1] M.K. Fix, P. Manser, D. Frei, W. Volken, R. Mini, E.J. Born, *An efficient framework for photon Monte Carlo treatment planning,* Phys. Med. Biol., 52:N425-437, 2007.

EP-1636

Clinical validation of Automated Planning process in rectal cancer IMRT treatment

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Purpose or Objective: Several studies suggest that IMRT can reduce toxicity in rectal cancer patients. A preconfigured plan model might improve daily clinical activity outcomes. Aim of this study was the evaluation of the performances of RapidPlan®Varian Medical System, a commercial model-based optimization engine, in locally advanced rectal cancer (LARC) IMRT plans in terms of planning target volume (PTV) coverage and Organs at Risk (OaRs) sparing.

Material and Methods: Between January 2014 and March 2014, 60 previously irradiated patients with LARC were retrospectively recruited: 40 IMRT plans were selected to configurate the Dose Volume Histogram (DVH) model and to train it. The remaining 20 were firstly manually optimized by 2 medical physicists and then used to validate the model as benchmark plans (BP). OaRs constrains followed Quantec guidelines. Three model based on different PTV objectives have been generated: DVH model 95-105%, DVH model 98-105% and DVH model 98-103% where more than 95%, 98% and 98% of the PTV received more than 95% of the prescription dose and less than 5%, 5% and 3% of the PTV received more than 105% of the prescription dose, respectively. The performances of automated plans (one series for each model) vs BP were statistically compared using Wilcoxon signed-rank test, for PTV V95 and V105, hot spot out of PTV (HToPTV), bladder mean dose (BmD) and maximum dose (BMD), bowel mean dose (BomD) and V45 (BV45). Two expert radiotherapists (observer1 and observer2) clinically validated in double blind the IMRT plans.

Results: A statistical significant improvement was observed for the following dosimetric parameters: HToPTV (for DVH model 98-105 and DVH model 98-103 plans, p=0.002 and p=0.005, respectively); BmD (DVH model 95-105 and DVH model 98-105 plans, p= 0.01 and p= 0.03, respectively). A statistically significant disadvantage in terms of BMD was observed for DVH model 98-103 and DVH model 98-105 (p=0.02 and p= 0.05, respectively). No statistical differences were recorded in term of BV45 and BomD and PTV V95 and V105. (TABLE 1) At a clinical validation, the two observers most frequently chose the test plans optimized from DVH model 98-103% (34 times versus 26 times of the BP).

	DVH model 95-105 vs BP (p value)	DVH model 98-105 vs BP (p value)	DVH model 98-103 vs BP (p value)
Bladder mean dose	0.01	0.03	0.13
Bladder maximum dose	0.35	0.02	0.05
Bowel mean dose	0.65	0.81	0.84
Bowel V45	0.75	0.70	0.90
Hot spot out of PTV	0.13	0.002	0.005

Conclusion: The results of this study show dosimetric and clinical improvements of IMRT plans optimized by knowledge-based planning models compared to BP. The data suggest and encourage the application of this engine into daily clinical practice.

EP-1637

Dose plan assessment of coplanar and non-coplanar beam angle optimization algorithms

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Purpose or Objective: To assess the performance of coplanar and non-coplanar beam angular optimization for two different algorithms integrated in a fully automated multicriterial plan generation system for nasopharyngeal tumour cases.

Material and Methods: A retrospective study including data of 40 nasopharyngeal cases was performed. In each plan, the primary tumour, up to 3 adenopathies, and ipsilateral and contralateral lymph nodes were irradiated with doses of 70 Gy, 59.4 Gy and/or 54 Gy delivered in 33 fractions, respectively. A 'wish-list' based on hard constraints and prioritized objectives for the target volumes and the organs at risk was tailored according to the local clinical practice. Seven coplanar equidistant angles (E7) were used in the standard plan. For each patient, this IMRT plan was compared to coplanar and non-coplanar IMRT plans with 5, 7 and 9 beam angles, optimized with a multicriterial beam angle optimization algorithm (A5, A7, A9), and an in-house derivative-free optimization algorithm (B5, B7, B9). Dose distribution quality for each plan was assessed through DVH analysis and a dose metrics weighted sum approach.

Results: Globally all generated plans presented a good dose distribution. On average, similar results have been obtained for both coplanar beam angle optimization algorithms. For non-coplanar beams, the best results were obtained with algorithm B. When compared with B coplanar cases, on average, slightly better results were achieved with non-coplanar plans for all number of beams (B5, B7 and B9). For algorithm A, on average, no relevant improvement was obtained with the non-coplanar optimization compared with the coplanar plans or the E7 plans. Despite these average results, in particular clinical cases, appreciable differences concerning organ sparing could be found. Up to 9 Gy difference in parotid sparing was achieved both with B9 and A9 coplanar plans when compared with E7 plans. This maximum dose sparing rose to 22 Gy when non-coplanar beams were considered. For the spinal cord, a maximum dose difference of 6 Gy was found between A9 and B9 both for coplanar and non-coplanar beam geometries. In the chiasm, B9 gave up to 5 Gy less than A9 in coplanar beams but this dose sparing for B9 rose to 35Gy for the non-coplanar geometry. For ears B5 non-coplanar plans achieved a better performance than A9 coplanar plans in 66% of the cases. For this structure, up to 15 Gy differences were found between B5 non-coplanar and A9 coplanar plans.

Conclusion: Using a dose metric weight sum approach two beam angle optimization algorithms were compared in a faster and systematic way. On average, both algorithms performed well for the tested clinical cases. However, the different beam angle optimization strategies intrinsic to each of the algorithms revealed to favour algorithm B for non-coplanar beam geometries while for coplanar beams no relevant differences were found between algorithms A and B.

EP-1638

Multicriteria optimisation for whole-pelvic VMAT planning in prostate patients

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Purpose or Objective: A Multicriteria Optimization (MCO) algorithm for VMAT planning that can generate Pareto-optimal plans was recently implemented in the RayStation TPS. The user can generate a plan database with a defined number of Pareto-optimal plans and can explore tradeoffs between different objectives in real time. This study investigates MCO for semi-automated VMAT planning for irradiation of prostate including pelvic lymph nodes.

Material and Methods: CT datasets of ten patients with high risk prostate cancer were used for this study. For each patient, a two stage VMAT plan (6 MV Elekta Agility linac) was generated, consisting of a stage 1 plan delivering 50.4 Gy to the lymph nodes (PTV-LN) and 56 Gy to the prostate (PTV-P) in a simultaneous integrated boost (SIB) in 28 fractions with a dual arc and a stage 2 plan delivering 22 Gy to the PTV-P in 11 fractions with a partial arc. The separation of the